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(54) **TURBINE BLADES**

TURBINENSCHAUFEL

AUBES DE TURBINE

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Description

BACKGROUND ART

[0001] Turbine blades that a gas turbine engine or the like is provided with reach a high temperature due to being exposed to combustion gas generated by a combustor. For this reason, various countermeasures have been implemented as shown in Patent Documents 1 to 4 in order to enhance the heat resistance of turbine blades. For example, Patent Document 3 discloses a turbine blade that partitions cooling air that is jetted out from a cooling hole with a projection.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0002]

[Patent Document 1] Japanese Patent No. 3997986
 [Patent Document 2] Japanese Patent No. 4752841
 [Patent Document 3] Japanese Unexamined Patent Application, First Publication No. H10-89005
 [Patent Document 4] Japanese Unexamined Patent Application, First Publication No. H06-093802

[0003] However, in Patent Document 3, since the top of the projection is open, the cooling air that rides over the projection is subject to being blown away by the main flow gas (combustion gas) that flows upward. That is to say, a portion of the cooling air ends up being blown away without heading along the outer wall surface of the blade body. For this reason, it is not possible to sufficiently improve the cooling effectiveness.

[0004] In recent years, further improvements in the output of gas turbine engines and the like have been sought, and thereby the temperature of the combustion gas generated in the combustor has more than ever before trended toward high temperatures.

[0005] For this reason, further improvement of the cooling effectiveness is required for turbine blades that a gas turbine engine and the like is provided with.

[0006] The present invention was achieved in view of the aforementioned circumstances, and has as its object to further raise the cooling effectiveness of turbine blades that a gas turbine engine and the like is provided with.

[0007] We acknowledge the disclosure in WO 2008/059620A1, JP 2001 012204 A, JP H10 89005 A, US 2009/304499 A1, US 2004/265488 A1, JP 2011 196360 A, US 4 529 358 A, EP 2 343 435 A1, JP 2011 064207 A and US 2008/286090 A1 of a turbine blade that is provided with a cooling air hole that penetrates from the inner wall surface to the outer wall surface of a blade body that is made to be hollow, and provided with a convex portion that is arranged in the inner portion of the cooling air hole and that is provided projecting out from the inner wall surface of the cooling air hole.

SUMMARY OF THE INVENTION

[0008] According to a first aspect of the present invention there is provided a turbine blade as defined in claim 1 as appended hereto.

[0009] According to a second aspect of the present invention there is provided a turbine blade as defined in claim 2 as appended hereto.

[0010] According to a third aspect of the present invention there is provided a turbine blade according to claim 3 as appended hereto.

EFFECTS OF THE INVENTION

[0011] In the present invention, since the convex portion is provided in the inner portion of the cooling air hole, the cooling air that has ridden over the convex portion is not affected by other flows such as a main flow gas. For this reason, it is possible to cause most of the cooling air that is jetted out from the cooling air hole to contribute to film cooling, without a portion of the cooling air being blown away by the main flow gas. Moreover, since the cooling air spreads out while flowing due to riding over the convex portion, it becomes possible to jet out the cooling air in a wider range.

[0012] According to the present invention, it is possible to jet out the cooling air in a wide range without reducing the cooling air that contributes to the cooling of the outer wall surface of the blade body, and so it is possible to raise the cooling effectiveness of the turbine blade.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a perspective view that shows an outline configuration of the turbine blade in the first embodiment of the present invention.

FIG. 2A is a vertical cross-sectional view of an outline drawing of the film cooling portion that the turbine blade in the first embodiment of the present invention is provided with.

FIG. 2B is a plan view including the convex portion of an outline drawing of the film cooling portion that the turbine blade in the first embodiment of the present invention is provided with.

FIG. 2C is a front elevation seen from the inner wall surface side of the blade body of an outline drawing of the film cooling portion that the turbine blade in the first embodiment of the present invention is provided with.

FIG. 3 is a schematic drawing that shows the distribution of the absolute velocities obtained by simulation that used the film cooling portion the turbine blade in the first embodiment of the present invention is provided with as a model.

FIG. 4 is a schematic drawing that shows the absolute velocities and flow directions at cross section A

to cross section J in FIG. 3.

FIG. 5 is a schematic drawing that shows the absolute velocities and flow directions in the vicinity of the convex portion in FIG. 3.

FIG. 6A is a vertical cross-sectional view of an outline drawing of the film cooling portion that the turbine blade in the second embodiment of the present invention is provided with.

FIG. 6B is a plan view including the convex portion of an outline drawing of the film cooling portion that the turbine blade in the second embodiment of the present invention is provided with.

FIG. 6C is a front elevation seen from the inner wall surface side of the blade body of an outline drawing of the film cooling portion that the turbine blade in the second embodiment of the present invention is provided with.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0014] Hereinbelow, one embodiment of the turbine blade according to the present invention shall be described with reference to the drawings. Note that in the following drawings, the scale of each member is suitably altered in order to make each member a recognizable size.

(First Embodiment)

[0015] FIG. 1 is a perspective view that shows the outline configuration of the turbine blade 1 of the present embodiment. The turbine blade 1 of the present embodiment is a turbine stator blade, and is provided with a blade body 2, band portions 3 that sandwich the blade body 2, and a film cooling portion 4.

[0016] The blade body 2 is arranged on the downstream side of a combustor that is not illustrated, and is arranged in the flow path of a combustion gas G (refer to FIG. 2A) that is generated by the combustor. This blade body 2 is made to have a blade shape having a leading edge 2a, a trailing edge 2b, a positive pressure surface 2c, and a negative pressure surface 2b. The blade body 2 is made to be hollow, to have an interior space for guiding cooling air to the inside. A cooling air flow path not illustrated is connected to the interior space of the blade body 2 whereby, for example, air that is extracted from a compressor that is installed on the upstream side of the combustor is introduced as the cooling air. The band portions 3 are provided sandwiching the blade body 2 from the height direction of the blade body 2, and function as a portion of the flow path wall of the combustion gas G. These band portions 3 are integrated with the tip side and hub side of the blade body 2.

[0017] FIG. 2A is a vertical cross-sectional view of an outline drawing of the film cooling portion 4. FIG. 2B is a plan view including a convex portion 6 described below of an outline drawing of the film cooling portion 4. FIG.

2C is a front elevation seen from the inner wall surface 2e side of the blade body 2 of an outline drawing of the film cooling portion 4. As shown in these drawings, the film cooling portion 4 is provided with a cooling air hole 5 and a convex portion 6.

[0018] The cooling air hole 5 is a through-hole that penetrates from the inner wall surface 2e to the outer wall surface 2f of the blade body 2, and is constituted from a straight pipe portion 5a on the inner wall surface 2e side, and a diameter expansion portion 5b at the outer wall surface 2f side. The straight pipe portion 5a is a section that extends in a linear shape, and the cross section shown in FIG. 2A is made to have a long hole shape. Also, the straight pipe portion 5a is sloped so that the end portion of the outer wall surface 2f side is arranged further to the downstream side of the main flow gas G that flows along the outer wall surface 2f of the blade body 2 than the end portion on the inner wall surface 2e side. The diameter expansion portion 5b is a section whose flow path cross section increases heading toward the outer wall surface 2f. Note that the diameter expansion portion 5b is made to be a shape in which the side wall surface 5c shown in FIG. 2A, FIG. 2B, and FIG. 2C broadens in the height direction of the blade body 2 heading from the inner wall surface 2e side to the outer wall surface 2f side.

[0019] This kind of cooling air hole 5 guides cooling air Y that is supplied from the interior space of the blade body 2 to the outer wall surface 2f, and after dispersing and spreading out the cooling air Y in the height direction of the blade body 2 in the diameter expansion portion 5b, jets it out it along the outer wall surface 2f.

[0020] The convex portion 6 is arranged in the inner portion of the cooling air hole 5, and is provided projecting from the inner wall surface of the cooling air hole 5. As shown in FIG. 2A, FIG. 2B, and FIG. 2C, the convex portion 6 is made to have a triangular pyramid shape in which a surface of the convex portion 6 on the side of the inner wall surface 2e of the blade body 2 is made to be a triangular collision surface 6a. Also, the convex portion 6 is provided at a region positioned on the downstream side of the flow direction of the combustion gas G (main flow gas), in the inner wall surface of the cooling air hole 5. Moreover, the convex portion 6 is provided at a connection region of the straight pipe portion 5a and the diameter expansion portion 5b.

[0021] Note that as shown in FIG. 1, a plurality of the film cooling portions 4 that are constituted as described above are provided in the turbine blade 1 of the present embodiment. The cooling air Y that is jetted out from this kind of film cooling portion 4 flows along the outer wall surface 2f of the blade body 2, and thereby the outer wall surface 2f of the blade body 2 is film cooled.

[0022] According to the turbine blade 1 of the present embodiment that has this kind of constitution, the cooling air flows into the cooling air hole 5 of the film cooling portion 4 from the inner part of the blade body 2. The cooling air Y that has flowed into the cooling air hole 5 is

guided in a straight manner by the straight pipe portion 5a in which the flow path surface area does not change, and in the diameter expansion portion 5b in which the flow path surface area widens in a continuous way, flows while spreading in the height direction of the blade body 2. Thereby, according to the cooling air hole 5 that the turbine blade 1 of the present embodiment is provided with, compared with a cooling air hole that consists only of a straight pipe portion, it is possible to jet out the cooling air Y in a wider range in the height direction of the blade body 2, and so it is possible to cool the outer wall surface 2f of the blade body 2 in a wider range.

[0023] Also, in the turbine blade 1 of the present embodiment, the convex portion 6 is provided in the inner portion of the cooling air hole 5. For this reason, the cooling air Y that has ridden over the convex portion 6 is not affected by the flow of the combustion gas G. For this reason, it is possible to cause most of the cooling air Y that is jetted out from the cooling air hole 5 to contribute to film cooling, without a portion of the cooling air Y being blown away by the combustion gas G. Moreover, since the cooling air Y spreads out while flowing due to riding over the convex portion 6, it becomes possible to jet out the cooling air Y in a wider range.

[0024] In this way, according to the turbine blade 1 of the present embodiment, it is possible to jet out the cooling air Y in a wide range without reducing the cooling air Y that contributes to the cooling of the outer wall surface 2f of the blade body 2, and so it is possible to raise the cooling effectiveness of the turbine blade 1.

[0025] Also, the convex portion 6 in the turbine blade 1 of the present embodiment is arranged in the inner wall surface of the cooling air hole 5, on the downstream side of the flow direction of the combustion gas G that flows along the outer wall surface 2f of the blade body 2. Thereby, it becomes possible to broadly jet out the cooling air Y in the height direction of the blade body 2.

[0026] Also, in the turbine blade 1 of the present embodiment, the convex portion 6 is provided at the connection region of the straight pipe portion 5a and the diameter expansion portion 5b. Since the diameter expansion portion 5b is spatially wider than the straight pipe portion 5a, due to the provision of the convex portion 6 in the connection region of the straight pipe portion 5a and the diameter expansion portion 5b, it is possible to ensure a space for the cooling air Y, which attempts to spread out by riding over the convex portion 6, to spread out. Accordingly, it is possible to jet out the cooling air Y in a wider range without the spreading out of the cooling air Y being impeded.

[0027] FIG. 3 to FIG. 5 are drawings that schematically show the result of simulating flows in the film cooling portion 4 of the turbine blade 1 of the present embodiment. FIG. 3 shows the distribution of the absolute velocities of the cooling air Y in the film cooling portion 4, FIG. 4 shows the absolute velocities and local flow directions of the cooling air Y at cross-section A to cross-section J in FIG. 3, and FIG. 5 shows the absolute velocities and local

flow directions in the vicinity of the convex portion 6. Note that as shown in FIG. 3 and FIG. 5, the cooling air Y flows from the straight pipe portion 5a side toward the diameter expansion portion 5b. Also, in FIG. 4 and FIG. 5, the local flow directions of the cooling air Y in the inner portion of the cooling air hole 5 are indicated with bold arrows.

[0028] As shown in these drawings (particularly E to J of FIG. 4), in the turbine blade 1 of the present embodiment, it is possible to confirm that the cooling air Y that has ridden over the convex portion 6 has spread out in the height direction of the blade body 2 without being affected by the combustion gas G.

[0029] Also, as shown in FIG. 5, it is apparent that a secondary vortex is formed at the downstream side of the convex portion 6.

[0030] Due to the formation of this kind of secondary vortex, the pressure loss in the inner portion of the cooling air hole 5 rises, and so it is possible to reduce the flow speed of the cooling air Y. As a result, the cooling air Y more easily spreads out in a wider range.

(Second Embodiment)

[0031] Next, the second embodiment of the present invention shall be described. Note that in the description of the present embodiment, descriptions of those portions that are the same as in the first embodiment described above shall be omitted or simplified.

[0032] FIG. 6A is a vertical cross-sectional view of an outline drawing of the film cooling portion 4A that the turbine blade of the present embodiment is provided with. FIG. 6B is a plan view including a convex portion 7 described below of an outline drawing of the film cooling portion 4A that the turbine blade of the present embodiment is provided with. FIG. 6C is a front elevation seen from the inner wall surface 2e side of the blade body 2 of an outline drawing of the film cooling portion 4A that the turbine blade of the present embodiment is provided with. As shown in these drawings, the film cooling portion 4A is provided with a convex portion 7 that is long in the direction that joins the inner wall surface 2e and the outer wall surface 2f of the blade body 2, instead of the convex portion 6 of the above embodiment.

[0033] The convex portion 7 is arranged in the inner portion of the cooling air hole 5, and is provided projecting from the inner wall surface of the cooling air hole 5. Also, as shown in FIG. 6A, FIG. 6B, and FIG. 6C, the convex portion 7 is made to have a triangular column shape in which a surface of the convex portion 7 on the side of the inner wall surface 2e of the blade body 2 is made to be a triangle shape. Also, the convex portion 7 is provided continuously from the end portion on the inner wall surface 2e of the blade body 2 side of the straight pipe portion 5a to the end portion on the outer wall surface 2f of the blade body 2 side of the straight pipe portion 5a.

[0034] In the turbine blade 1 of the present embodiment that has this kind of constitution, the cooling air Y that has ridden over the convex portion 7 is not affected

by the flow of the combustion gas G. For this reason, it is possible to cause most of the cooling air Y that is jetted out from the cooling air hole 5 to contribute to film cooling, without a portion of the cooling air Y being blown away by the combustion gas G. Moreover, since the cooling air Y spreads out while flowing due to riding over the convex portion 7, it becomes possible to jet out the cooling air Y in a wider range.

[0035] In this way, in the turbine blade of the present embodiment, it is possible to jet out the cooling air Y in a wide range without reducing the cooling air Y that contributes to the cooling of the outer wall surface 2f of the blade body 2, and so it is possible to raise the cooling effectiveness of the turbine blade.

[0036] Hereinabove, preferred embodiments of the present invention are described while referring to the appended drawings, but the present invention is not limited to the aforementioned embodiments. The various shapes and combinations of each constituent member shown in the embodiments described above refer to only examples.

[0037] For example, the arrangement position and number of the film cooling portion 4 in the blade body 2 of the aforementioned embodiments are just one example, and are suitably changeable in accordance with the cooling performance that is required in the turbine blade.

[0038] Also, in the aforementioned embodiments, a description is given for a constitution in which the turbine blade is a stator blade. However, the present invention is not limited thereto, and does not exclude constitutions that install film cooling portions in the rotor blade.

[0039] Also, the convex portion 6 in the aforementioned embodiment may be installed in the inner portion of the straight pipe portion 5a.

INDUSTRIAL APPLICABILITY

[0040] In a turbine blade that a gas turbine engine or the like is provided with, it is possible to jet out cooling air in a wide range without reducing the cooling air that contributes to the cooling of the outer wall surface of a hollow blade body, and it is possible to raise the cooling effectiveness of the turbine blade.

DESCRIPTION OF THE REFERENCE SYMBOLS

[0041]

- 1: Turbine blade
- 2: Blade body
- 2a: Leading edge
- 2b: Trailing edge
- 2c: Positive pressure surface
- 2d: Negative pressure surface
- 2e: Inner wall surface
- 2f: Outer wall surface
- 3: Band portion
- 4, 4A: Film cooling portion

- 5: Cooling air hole
- 5a: Straight pipe portion
- 5b: Diameter expansion portion
- 6: Convex portion
- 6a: Collision surface
- G: Combustion gas (main flow gas)
- Y: Cooling air

10 Claims

1. A turbine blade (1) that is provided with a cooling air hole (5) that penetrates from an inner wall surface (2e) to an outer wall surface (2f) of a blade body (2) that is made to be hollow, wherein the cooling air hole (5) has a straight pipe portion (5a) that is provided at the inner wall surface (2e) side of the blade body (2) and a diameter expansion portion (5b) that is provided at the outer wall surface (2f) side of the blade body (2), and wherein the turbine blade (1) comprises:

a convex portion (6) that is arranged in an inner portion of the cooling air hole (5) and that is provided projecting out from an inner wall surface of the cooling air hole (5),

wherein the convex portion (6) is provided on the inner wall surface of the cooling air hole (5) that is positioned at the downstream side of a flow direction of a main flow gas (G) that flows along the outer wall surface (2f) of the blade body (2),

characterized in that the convex portion (6) is made to have a triangular pyramid shape in which a surface of the convex portion (6) on the side of the inner wall surface (2e) of the blade body (2) is made to be a triangular collision surface (6a), and

the convex portion (6) is provided at the straight pipe portion (5a).

2. A turbine blade (1) that is provided with a cooling air hole (5) that penetrates from an inner wall surface (2e) to an outer wall surface (2f) of a blade body (2) that is made to be hollow, wherein the cooling air hole (5) has a straight pipe portion (5a) that is provided at the inner wall surface (2e) side of the blade body (2) and a diameter expansion portion (5b) that is provided at the outer wall surface (2f) side of the blade body (2), and wherein the turbine blade (1) comprises:

a convex portion (6) that is arranged in an inner portion of the cooling air hole (5) and that is provided projecting out from an inner wall surface (2e) of the cooling air hole,

wherein the convex portion (6) is provided on the inner wall surface (2e) of the cooling air hole

(5) that is positioned at the downstream side of a flow direction of a main flow gas (G) that flows along the outer wall surface (2f) of the blade body (2),

characterized in that the convex portion (6) is made to have a triangular pyramid shape in which surface of the convex portion (6) on the side of the inner wall surface (2e) of the blade body (2) is made to be a triangular collision surface (6a), and the convex portion (6) is provided at a connection portion of the straight pipe portion and the diameter expansion portion (5b).

3. A turbine blade (1) that is provided with a cooling air hole (5) that penetrates from an inner wall surface (2e) to an outer wall surface (2f) of a blade body (2) that is made to be hollow, wherein the cooling air hole (5) has a straight pipe portion (5a) that is provided at the inner wall surface (2e) side of the blade body (2) and a diameter expansion portion (5b) that is provided at the outer wall surface (2f) side of the blade body (2), and wherein the turbine blade (1) comprises:

a convex portion (7) that is arranged in an inner portion of the cooling air hole (5) and that is provided projecting out from an inner wall surface (2e) of the cooling air hole (5),

wherein the convex portion (7) is provided on the inner wall surface (2e) of the cooling air hole (5) that is positioned at the downstream side of a flow direction of a main flow gas (G) that flows along the outer wall surface (2f) of the blade body (2),

characterized in that the convex portion (7) is made to have a triangular column shape in which a surface of the convex portion (7) on the side of the inner wall surface (2e) of the blade body (2) is made to be a triangle shape,

the convex portion (7) is provided continuously from an end portion on the inner wall surface (2e) of the blade body side of the straight pipe portion (5a) to an end portion on the outer wall surface (2f) of the blade body side of the straight pipe portion (5a), and

the convex portion (7) is not provided in the diameter expansion portion (5b).

Patentansprüche

1. Turbinenschaufel (1), welche mit einem Kühlungs-Luftloch (5) versehen ist, welches eine innere Wandoberfläche (2e) bis zu einer äußeren Wandoberfläche (2f) eines Schaufelkörpers (2) durchdringt, welcher gestaltet ist, um hohl zu sein, wobei das Kühlungs-Luftloch (5) einen geraden Röhrenabschnitt

(5a) aufweist, welcher an der inneren Wandoberflächenseite (2e) des Schaufelkörpers (2) bereitgestellt ist und einen Durchmesser-Expansionsabschnitt (5b), welcher an der äußeren Wandoberflächenseite (2f) des Schaufelkörpers (2) bereitgestellt ist und wobei die Turbinenschaufel (1) Folgendes umfasst:

einen konvexen Abschnitt (6), welcher in einem inneren Abschnitt des Kühlungs-Luftlochs (5) angeordnet ist und von einer inneren Wandoberfläche des Kühlungs-Luftlochs (5) nach außen vorspringend bereitgestellt ist, wobei der konvexe Abschnitt (6) an der inneren Wandoberfläche des Kühlungs-Luftlochs (5) bereitgestellt ist, welches an der nachgelagerten Seite einer Strömungsrichtung eines Hauptströmungsgases (G) positioniert ist, welches entlang der äußeren Wandoberfläche (2f) des Schaufelkörpers (2) fließt,

dadurch gekennzeichnet, dass

der konvexe Abschnitt (6) so gestaltet ist, dass er eine dreieckige Pyramidenform aufweist, wobei eine Oberfläche des konvexen Abschnittes (6) an der Seite der inneren Wandoberfläche (2e) des Schaufelkörpers (2) als eine dreieckige Kollisionsoberfläche (6a) gestaltet ist, und der konvexe Abschnitt (6) an dem geraden Röhrenabschnitt (5a) bereitgestellt ist.

2. Turbinenschaufel (1), welche mit einem Kühlungs-Luftloch (5) versehen ist, welches eine innere Wandoberfläche (2e) bis zu einer äußeren Wandoberfläche (2f) eines Schaufelkörpers (2) durchdringt, welcher gestaltet ist, um hohl zu sein, wobei das Kühlungs-Luftloch (5) einen geraden Röhrenabschnitt (5a) aufweist, welcher an der inneren Wandoberflächenseite (2e) des Schaufelkörpers (2) bereitgestellt ist und einen Durchmesser-Expansionsabschnitt (5b), welcher an der äußeren Wandoberflächenseite (2f) des Schaufelkörpers (2) bereitgestellt ist und wobei die Turbinenschaufel (1) Folgendes umfasst:

einen konvexen Abschnitt (6), welcher in einem inneren Abschnitt des Kühlungs-Luftlochs (5) angeordnet ist und von einer inneren Wandoberfläche (2e) des Kühlungs-Luftlochs nach außen vorspringend bereitgestellt ist, wobei der konvexe Abschnitt (6) an der inneren Wandoberfläche (2e) des Kühlungs-Luftlochs (5) bereitgestellt ist, welches an der nachgelagerten Seite einer Strömungsrichtung eines Hauptströmungsgases (G) positioniert ist, welches entlang der äußeren Wandoberfläche (2f) des Schaufelkörpers (2) strömt,

dadurch gekennzeichnet, dass

der konvexe Abschnitt (6) so gestaltet ist, dass er eine dreieckige Pyramidenform aufweist, wobei eine Oberfläche des konvexen Abschnittes

(6) an der Seite der inneren Wandoberfläche (2e) des Schaufelkörpers (2) als eine dreieckige Kollisionsoberfläche (6a) gestaltet ist, und der konvexe Abschnitt (6) an einem Verbindungsabschnitt des geraden Röhrenabschnittes und des Durchmesser-Expansionsabschnittes (5b) bereitgestellt ist.

3. Turbinenschaufel (1), welche mit einem Kühlungs-Luftloch (5) versehen ist, welches eine innere Wandoberfläche (2e) bis zu einer äußeren Wandoberfläche (2f) eines Schaufelkörpers (2) durchdringt, welcher gestaltet ist, um hohl zu sein, wobei das Kühlungs-Luftloch (5) einen geraden Röhrenabschnitt (5a) aufweist, welcher an der inneren Wandoberflächen­seite (2e) des Schaufelkörpers (2) bereitgestellt ist und einen Durchmesser-Expansionsabschnitt (5b), welcher an der äußeren Wandoberflächen­seite (2f) des Schaufelkörpers (2) bereitgestellt ist und wobei die Turbinenschaufel (1) Folgendes umfasst:

einen konvexen Abschnitt (7), welcher in einem inneren Abschnitt des Kühlungs-Luftlochs (5) angeordnet ist und von einer inneren Wandoberfläche (2e) das Kühlungs-Luftlochs (5) nach außen vorspringend bereitgestellt ist, wobei der konvexe Abschnitt (7) an der inneren Wandoberfläche (2e) des Kühlungs-Luftlochs (5) bereitgestellt ist, welches an der nachgelagerten Seite einer Strömungsrichtung eines Hauptströmungsgases (G) positioniert ist, welches entlang der äußeren Wandoberfläche (2f) des Schaufelkörpers (2) strömt, **dadurch gekennzeichnet, dass** der konvexe Abschnitt (7) so gestaltet ist, dass er eine dreieckige Säulenform aufweist, wobei eine Oberfläche des konvexen Abschnittes (7) an der Seite der inneren Wandoberfläche (2e) des Schaufelkörpers (2) als eine Dreiecksform (6a) gestaltet ist, und der konvexe Abschnitt (7) kontinuierlich von einem Endabschnitt an der inneren Wandoberfläche (2e) der Schaufelkörperseite des geraden Röhrenabschnittes (5a) bis zu einem Endabschnitt auf der äußeren Wandoberfläche (2f) der Schaufelkörperseite des geraden Röhrenabschnittes (5a) bereitgestellt ist, und der konvexe Abschnitt (7) nicht in dem Durchmesser-Expansionsabschnitt (5b) bereitgestellt ist.

Revendications

1. Aube de turbine (1) qui est munie d'un orifice d'air de refroidissement (5) qui pénètre depuis une surface de paroi interne (2e) jusqu'à une surface de

paroi externe (2f) d'un corps d'aube (2) qui est conçu pour être creux, dans laquelle l'orifice d'air de refroidissement (5) comporte une partie de tube rectiligne (5a) qui est prévue ducôté de la surface de paroi interne (2e) du corps d'aube (2) et une partie d'extension de diamètre (5b) qui est prévue du côté de la surface de paroi externe (2f) du corps d'aube (2), et dans laquelle l'aube de turbine (1) comprend : une partie convexe (6) qui est agencée dans une partie interne de l'orifice d'air de refroidissement (5) et qui est prévue pour faire saillie vers l'extérieur depuis une surface de paroi interne de l'orifice d'air de refroidissement (5) ; dans laquelle :

la partie convexe (6) est prévue sur la surface de paroi interne de l'orifice d'air de refroidissement (5) qui est positionnée du côté aval d'une direction d'écoulement d'un gaz d'écoulement principal (G) qui s'écoule le long de la surface de paroi externe (2f) du corps d'aube (2) ; **caractérisée en ce que :**

la partie convexe (6) est constituée pour présenter une forme de pyramide triangulaire dans laquelle une surface de la partie convexe (6) sur le côté de la surface de paroi interne (2e) du corps d'aube (2) est constituée pour être une surface de collision triangulaire (6a) ; et la partie convexe (6) est prévue sur la partie de tube rectiligne (5a).

2. Aube de turbine (1) qui est munie d'un orifice d'air de refroidissement (5) qui pénètre depuis une surface de paroi interne (2e) jusqu'à une surface de paroi externe (2f) d'un corps d'aube (2) qui est conçu pour être creux, dans laquelle l'orifice d'air de refroidissement (5) comporte une partie de tube rectiligne (5a) qui est prévue du côté de la surface de paroi interne (2e) du corps d'aube (2) et une partie d'extension de diamètre (5b) qui est prévue du côté de la surface de paroi externe (2f) du corps d'aube (2), et dans laquelle l'aube de turbine (1) comprend :

une partie convexe (6) qui est agencée dans une partie interne de l'orifice d'air de refroidissement (5) et qui est prévue pour faire saillie vers l'extérieur depuis une surface de paroi interne (2e) de l'orifice d'air de refroidissement ; dans laquelle

la partie convexe (6) est prévue sur la surface de paroi interne (2e) de l'orifice d'air de refroidissement (5) qui est positionnée du côté aval d'une direction d'écoulement d'un gaz d'écoulement principal (G) qui s'écoule le long de la surface de paroi externe (2f) du corps d'aube (2) ;

caractérisée en ce que :

la partie convexe (6) est constituée pour présenter une forme de pyramide triangulaire dans laquelle une surface de la partie convexe (6) sur le côté de la surface de paroi interne (2e) du corps d'aube (2) est constituée pour être une surface de collision triangulaire (6a) ; et
la partie convexe (6) est prévue sur une partie de connexion de la partie de tube rectiligne et de la partie d'extension de diamètre (5b).

3. Aube de turbine (1) qui est munie d'un orifice d'air de refroidissement (5) qui pénètre depuis une surface de paroi interne (2e) jusqu'à une surface de paroi externe (2f) d'un corps d'aube (2) qui est conçu pour être creux, dans laquelle l'orifice d'air de refroidissement (5) comporte une partie de tube rectiligne (5a) qui est prévue du côté de la surface de paroi interne (2e) du corps d'aube (2) et une partie d'extension de diamètre (5b) qui est prévue du côté de la surface de paroi externe (2f) du corps d'aube (2), et dans laquelle l'aube de turbine (1) comprend :
une partie convexe (7) qui est agencée dans une partie interne de l'orifice d'air de refroidissement (5) et qui est prévue pour faire saillie vers l'extérieur depuis une surface de paroi interne (2e) de l'orifice d'air de refroidissement (5) ; dans laquelle :

la partie convexe (7) est prévue sur la surface de paroi interne (2e) de l'orifice d'air de refroidissement (5) qui est positionnée du côté aval d'une direction d'écoulement d'un gaz d'écoulement principal (G) qui s'écoule le long de la surface de paroi externe (2f) du corps d'aube (2) ;

caractérisée en ce que :

la partie convexe (7) est constituée pour présenter une forme de colonne triangulaire selon laquelle une surface de la partie convexe (7) sur le côté de la surface de paroi interne (2e) du corps d'aube (2) est constituée de telle sorte qu'elle présente une forme de triangle ; et
la partie convexe (7) est prévue en continu depuis une partie d'extrémité sur la surface de paroi interne (2e) du côté du corps d'aube de la partie de tube rectiligne (5a) jusqu'à une partie d'extrémité sur la surface de paroi externe (2f) du côté du corps d'aube de la partie de tube rectiligne (5a) ; et la partie convexe (7) n'est pas prévue dans la partie d'extension de diamètre (5b).

FIG. 1

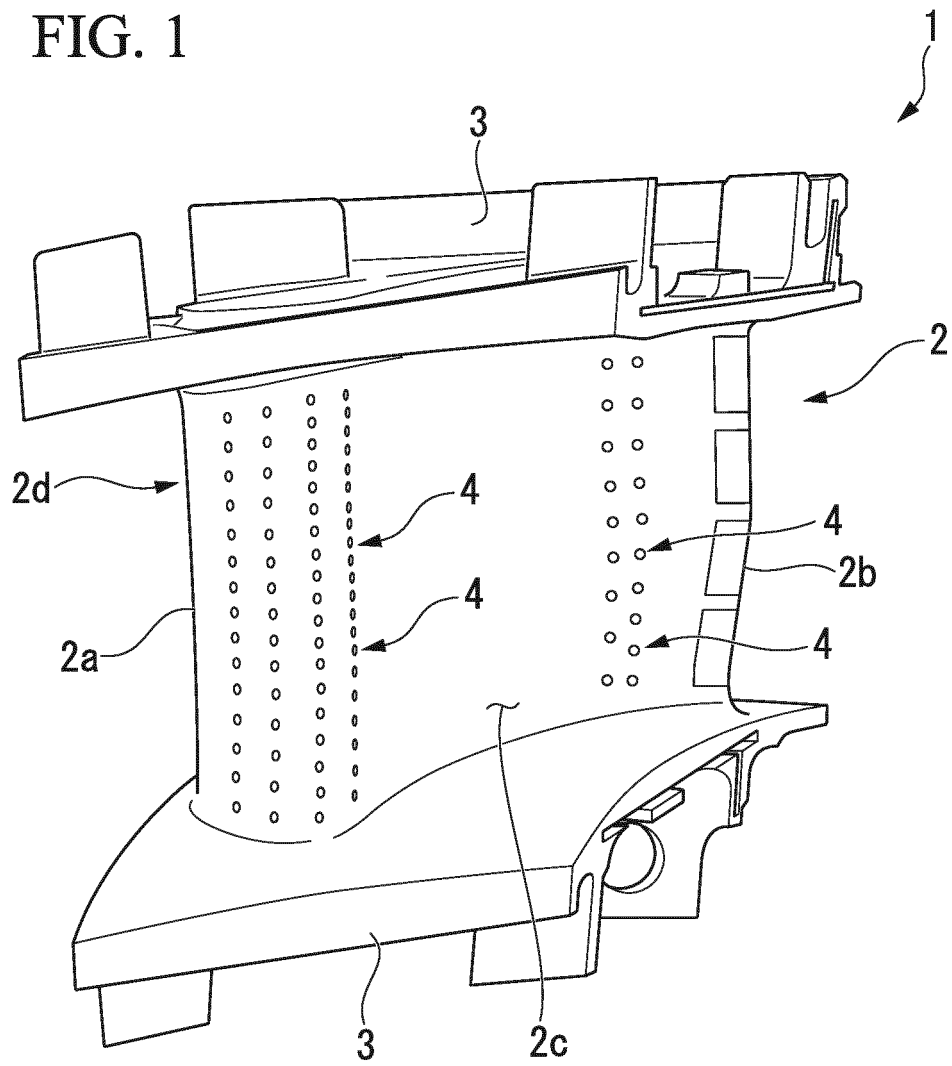


FIG. 2A

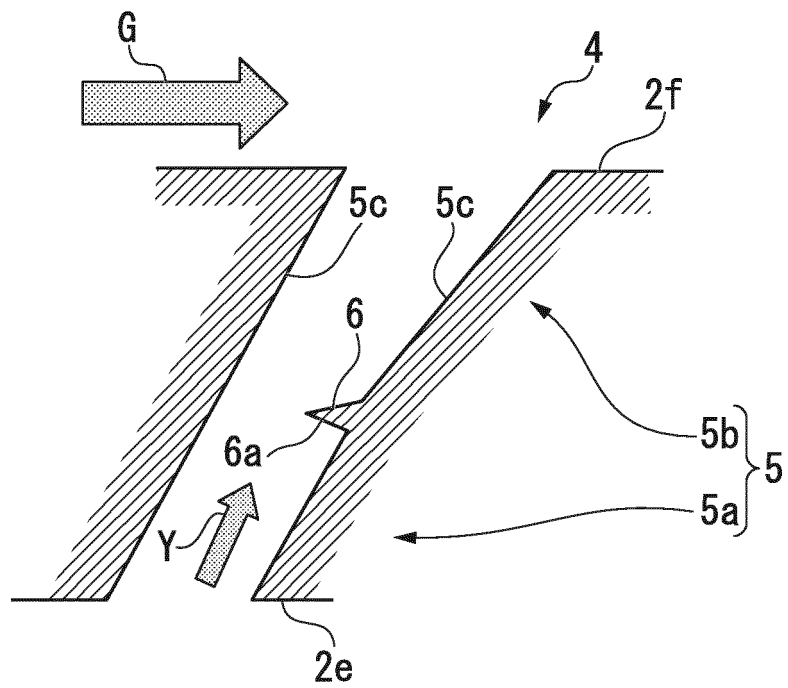


FIG. 2B

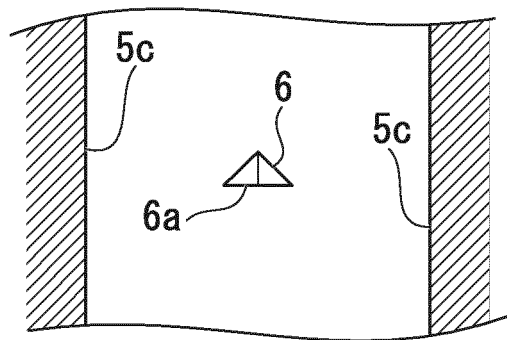
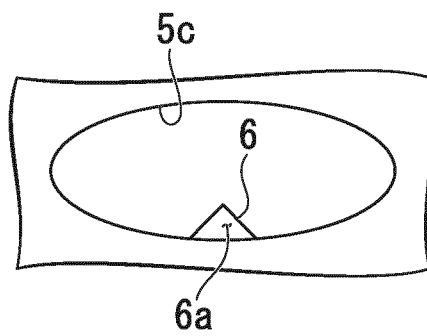


FIG. 2C



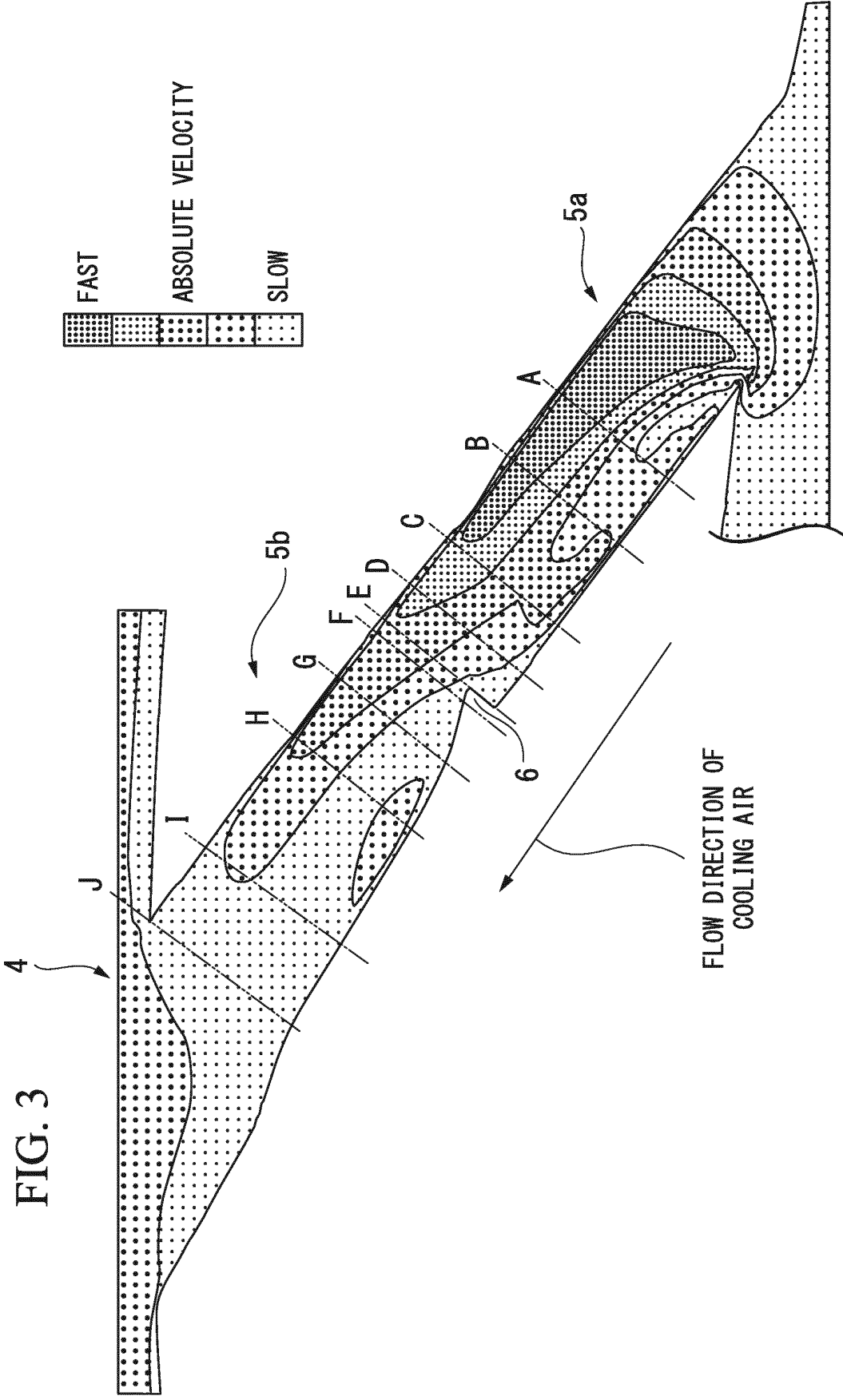


FIG. 4

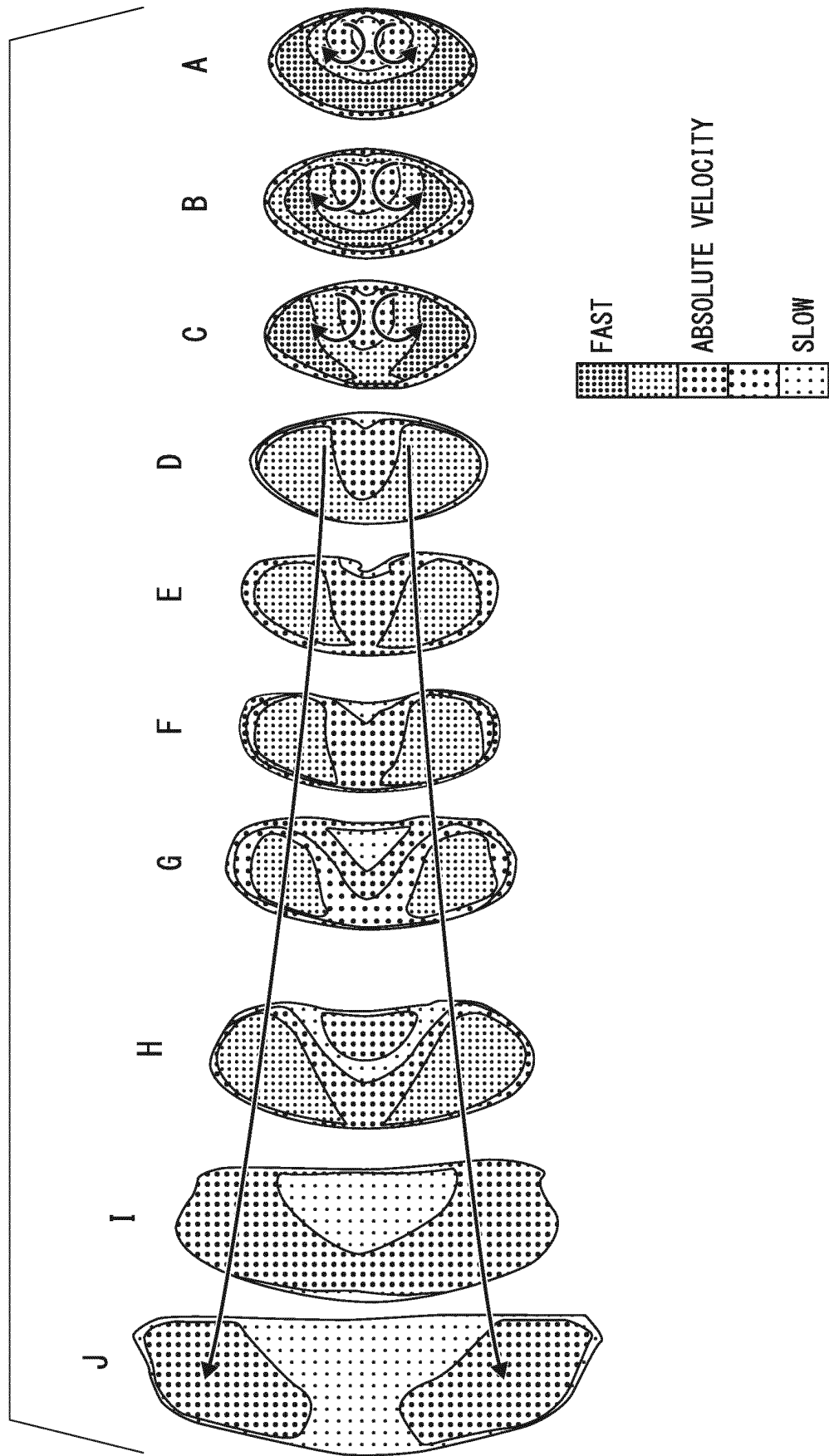


FIG. 5

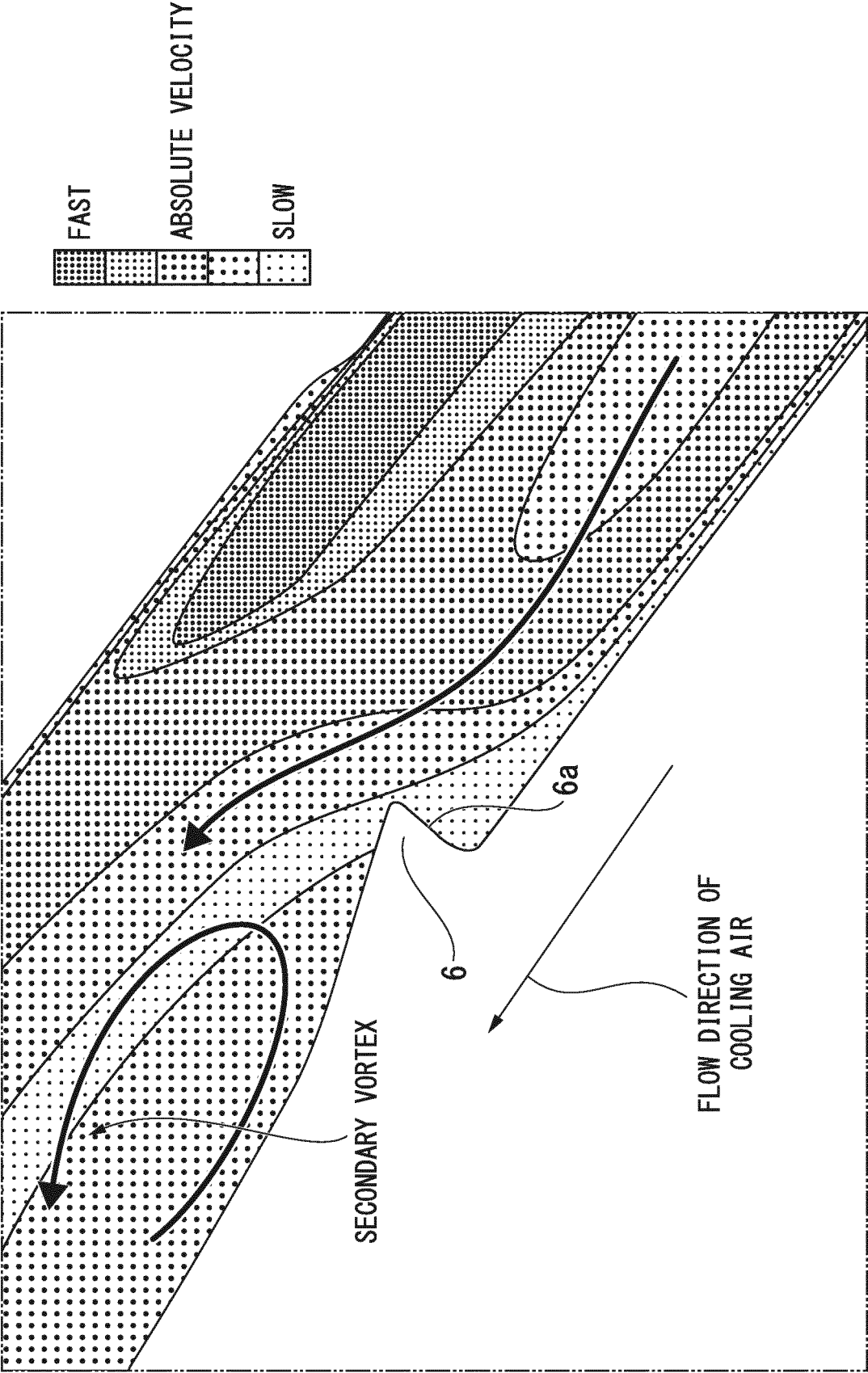


FIG. 6A

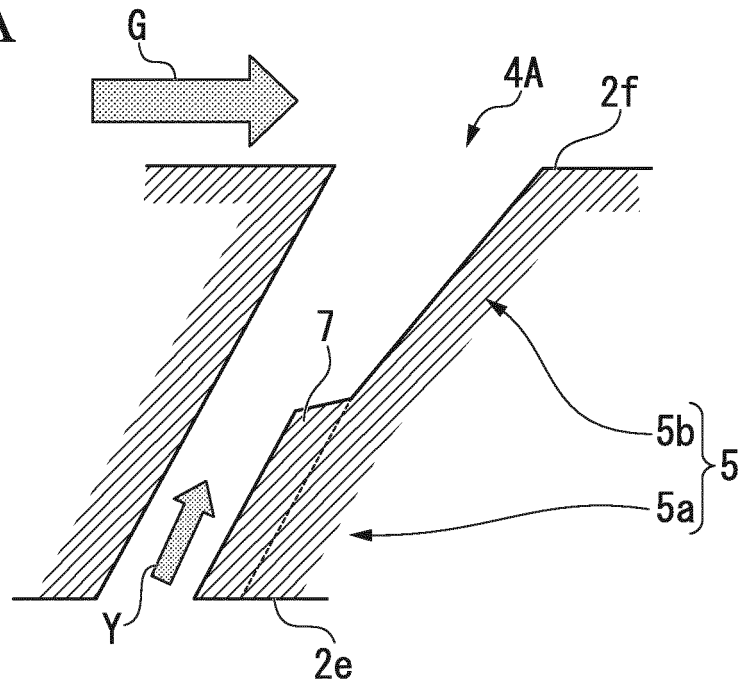


FIG. 6B

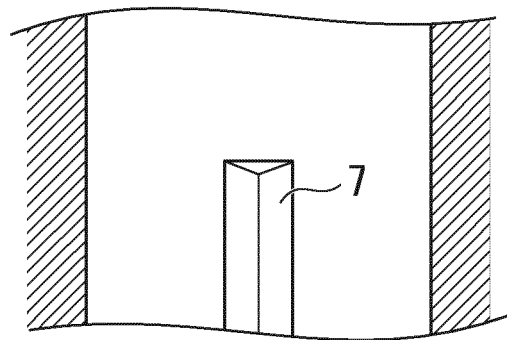
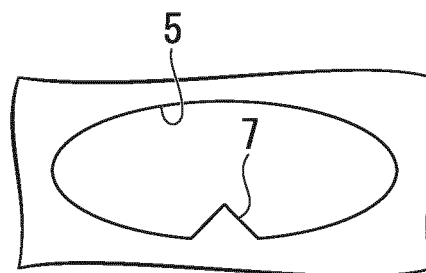


FIG. 6C



REFERENCES CITED IN THE DESCRIPTION

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